Functional outcome of patients with spinal cord injury: rehabilitation outcome study

MC Schönherr Rehabilitation Centre Beatrixoord, Haren and Department of Rehabilitation, Groningen University Hospital, Groningen, **JW Groothoff** Northern Centre for Health Care Research, University of Groningen, Groningen, **GA Mulder** Rehabilitation Centre Beatrixoord, Haren and **WH Eisma** Department of Rehabilitation, Groningen University Hospital, Groningen, The Netherlands

Received 9th June 1998; returned for revisions 12th November 1998; revised manuscript accepted 13th January 1999.

Objective: To increase our knowledge of neurological recovery and functional outcome of patients with spinal cord injuries in order to make more successful rehabilitation programmes based on realistic goals.
Design: Descriptive analysis of data gathered in an information system.
Setting: Rehabilitation centre in The Netherlands with special department for patients with spinal cord injuries.
Subjects: Fifty-five patients with traumatic spinal cord lesions admitted to the rehabilitation centre from 1988 to 1994.
Main outcome measures: The functional improvement was presented in terms of progress in independence in nine daily activity skills. Independence was rated on a four-point scale.
Results: From admission to discharge, lesions in 100% of patients with tetraplegia and 96% of patients with paraplegia remained complete. Significant progress in independence was made in self-care, ambulation and bladder and bowel care. Differences were found in the extent of functional improvement between subgroups of patients with different levels and extent of lesion. Contrary to expectations based on theoretical models, patients with complete paraplegia did not achieve maximal independence in self-care. Independent walking was only attained by patients with incomplete lesions. Regarding outcome of bladder and bowel care, poor results were found, especially the independence in defaecation and toilet transfers.
Conclusions: The results of this study provided more insight into the functional outcome of a group of patients with traumatic spinal cord injury. More research is needed to evaluate the rehabilitation programmes for these patients.

Address for correspondence: MC Schönherr, Rehabilitation Centre Beatrixoord, PO Box 30.002, NL-9750 RA Haren, The Netherlands.

0269–2155(99)CR264OA

Introduction

Following the definitions set down by the World Health Organization in 1980, the philosophy of rehabilitation is to reduce disabilities and handicaps resulting from impairments caused by trauma or disease.[1] Patients with spinal cord injuries (SCI) are confronted with motor and sensory deficits and dysfunction of bladder and bowel, leading to disabilities in activities of daily living.[2] The aim of rehabilitation is to teach patients with SCI how to achieve an optimal independent and satisfying lifestyle in their own community. Fortunately, most patients go home after rehabilition and a significant number achieve functional independence.[3–5]

To create successful rehabilitation programmes based on realistic goals, the prognosis of impairments, disabilities and handicaps should be clear. In recent years much attention has been paid to the neurological outcome after SCI. In several studies motor and sensory recovery following traumatic SCI has been quantified, based on the initial level of injury.[6–8] Most of the motor recovery occurs within the first six months after injury.[6]

The degree of functional improvement, which is more relevant in predicting rehabilitation outcome, depends on the level and extent of lesion. Various theoretical models have been developed and studied to predict potential physical abilities based on spared motor and sensory functions.[4,5,9–11] However, other factors like age and motivation seem to be important too. Little systematic research is available concerning the number of patients who actually achieve the expected level of independence.

Many articles focus on self-care of patients with tetraplegia.[12–14] C6 and C7 are critical levels for achieving independence in daily activities.[14] Most authors agree that patients with paraplegia can achieve independence in self-care skills. Ambulation is the subject of several studies with a diversity of results.[15–19] The outcome of bladder and bowel care and incontinence of patients with spinal cord injuries is comparatively unknown.

This study gives an epidemiological description of the recovery of the impairments and disabilities of a group of spinal cord injury patients during an inpatient rehabilitation period. The functional improvement of these patients is presented in terms of progress in independence in daily activity skills. Subgroups with different levels and extent of lesion were analysed regarding independence in self-care, ambulation and bladder and bowel care. We compared our results with available information on expected independence in other studies.

Methods

In 1988 the Beatrixoord Rehabilitation Centre started the assessment of medical and functional data of patients with SCI, who were registered in the Rehabilitation Information System – Information System for patients with spinal cord injury (RIS-DIS). This information system was developed to evaluate the rehabilitation treatment of SCI patients in The Netherlands and to work out a prognostic model for functional outcome. The rehabilitation team (physician for rehabilitation medicine, nurse, physiotherapist, occupational therapist) provided detailed information about the medical and functional progress of those patients. Data were registered at six-week intervals following uniform instructions. In this study data were gathered at the first assessment after admission and the last before discharge from inpatient rehabilitation.

Data were obtained for 55 patients with traumatic SCI, consecutively admitted to the rehabilitation centre from 1988 to 1994. In order to describe the study group they were divided into four subgroups with different levels and extent of lesion, using the standards for neurological and functional classification developed by the American Spinal Injury Association (ASIA) in 1992.[20,21] According to these standards the neurological level of injury was defined as the most caudal segment of the spinal cord with normal motor function. Patients without function in the lowest sacral segment (complete lesions) at discharge form subgroups A and B. Subgroup A consisted of 10 patients with complete lesions at levels C4 to T1 (tetraplegia), subgroup B of 22 patients with lesions at levels below T1 (paraplegia). The patients with any motor or sensory function below the neurological level which included the lowest sacral segment (incomplete

lesions) formed subgroups C (17 patients with lesions at C4 to T1) and D (six patients with lesions below T1).

To describe the disabilities of these patients nine relevant activities of daily living selected from the RIS-DIS were assessed. Self-care skills were feeding, upper body dressing and lower body dressing, either in bed or in chair. Ambulation consists of chair transfer, manual wheelchair propulsion and functional walking. Independent walking was defined as the ability to walk about 50 metres with or without assistant devices. Bladder and bowel care involved skills regarding bladder voiding, defaecation and toilet transfer. Continence for urine and bowels with or without the use of collection devices was assessed separately. Incontinence was defined as the unpredictable loss or spills of urine or faeces.

Independence was defined as the observed ability to perform an activity without the help of another person (with or without appliance or orthosis). For all skills the degree of independence was rated on a four-point scale: independence 3 points, little assistance of another person 2 points, a lot of assistance 1 point and done by another person 0 points. The mean score per skill was 0–3 points. The mean score per set of three skills (self-care, ambulation and bladder and bowel care) was 0–9 points. These scores were calculated at admission and discharge and differences were examined by paired *t*-tests. Data analysis was carried out using SPSS/PC program.

Results

General characteristics

The study population consisted of 47 males (85%) and eight females. Their age ranged from 16 to 73 years with a mean age of 33 years. All 55 patients had traumatic spinal cord lesions, which occurred in the period from 1988 to 1994. Twenty-five injuries (46%) were caused by traffic accidents, 11 (20%) by industrial accidents, nine (16%) were sport accidents of which four were caused by diving. There were two victims of violence (4%) and one patient attempted suicide. In the acute phase patients were admitted to university or general hospitals, where 39 (71%) of them underwent surgical interventions. Twelve patients (22%) were treated with traction or immobilization. The mean length of stay in hospital was 29 days (range 3–97 days). The mean stay in the rehabilitation centre was 254 days for the whole study group. Patients in subgroup A stayed on average 375 days, in subgroup B 250 days, in subgroup C 200 days, in subgroup D 220 days.

Neurological recovery

At admission 22 patients had an incomplete lesion. Of 33 patients with complete lesions 10 patients had lesions at or above T1. All those 10 patients kept complete lesions (subgroup A). Of 23 patients with complete lesions below T1 at admission 22 (96%) kept complete lesions (subgroup B).

Functional improvement

Results of the whole study group regarding nine daily activities are presented in Table 1. Comparison of the independence rates at admission and at discharge showed a significant increase in independence for all skills.

Table 2 shows changes in independence of four different subgroups regarding self-care, ambulation and bladder and bowel care. Except for self-care in subgroup D and bladder and bowel care in subgroup A, significant progress was made in independence in all subgroups.

Independence at discharge

Independence rates of eating warm meals, dressing upper and lower body at discharge are presented in Table 3. At discharge, eating and upper body dressing was done independently by patients in subgroup B; patients of subgroups C and D showed reasonably good results. Lower body dressing led to more dependence, especially in subgroup A.

Scores regarding transfers, manual wheelchair propulsion and walking are summarized in Table 4. Making transfers from bed to chair was done independently by most, but not all patients in subgroups B, C and D. Regarding wheelchair propulsion maximal scores were found in those subgroups and a submaximal score in subgroup A. Independent walking over 50 metres with or without assistant devices was achieved by 15

Table 1 Independence rates of study group regarding nine activities of daily living at admission and discharge (maximum 3.0). Differences were examined by paired *t*-tests

	Admission		Discharge		Difference	
	Mean	(SD)	Mean	(SD)	*t*	*p*-value
Feeding	2.1	(1.0)	2.7	(0.6)	–4.8	*
Dressing upper body	1.6	(1.2)	2.7	(0.6)	–7.5	*
Dressing lower body	0.9	(1.1)	2.2	(1.1)	–8.1	*
Bed transfer	1.0	(1.1)	2.4	(1.1)	–9.2	*
Wheelchair	1.9	(1.3)	2.9	(0.4)	–5.9	*
Walking	0.3	(0.9)	1.0	(1.4)	–4.5	*
Bladder voiding	0.5	(1.2)	2.5	(1.2)	–9.7	*
Defaecation	0.4	(1.0)	1.6	(1.5)	–6.2	*
Toilet transfer	0.4	(0.9)	1.7	(1.4)	–6.8	*

*p <0.01.

Table 2 Independence rates of four subgroups regarding self-care, ambulation and bladder and bowel care at admission and discharge (maximum 9.0). Differences were examined by paired *t*-tests

		Admission		Discharge		Difference	
	N	Mean	(SD)	Mean	(SD)	*t*	*p*-value
Self-care							
A	10	2.5	(2.0)	5.4	(2.5)	–5.1	0.001*
B	22	6.0	(2.3)	8.5	(1.1)	–6.2	0.000*
C	17	4.2	(2.7)	7.5	(1.7)	–5.1	0.000*
D	6	4.0	(3.6)	8.0	(2.4)	–3.2	0.025 NS
Ambulation							
A	10	1.3	(1.3)	3.8	(1.5)	–5.5	0.000*
B	22	3.5	(1.5)	5.7	(1.2)	–7.7	0.000*
C	17	4.2	(3.4)	8.2	(1.6)	–4.9	0.000*
D	6	2.7	(3.0)	7.3	(2.4)	–5.3	0.003*
Bladder and bowel care							
A	10	0.6	(1.3)	2.2	(2.9)	–1.9	0.091 NS
B	22	0.9	(1.6)	4.3	(2.7)	–8.8	0.000*
C	17	2.8	(3.3)	7.9	(2.1)	–5.8	0.000*
D	6	0.5	(1.2)	7.0	(3.6)	–4.5	0.006*

*p <0.01.

Table 3 Independence rates of four subgroups regarding self-care at discharge (maximum 3.0)

		Feeding		Dressing upper body		Dressing lower body	
	N	Mean	(SD)	Mean	(SD)	Mean	(SD)
A	10	2.0	(0.8)	2.3	(0.9)	1.1	(1.0)
B	22	3.0	(0.0)	3.0	(0.2)	2.6	(1.0)
C	17	2.6	(0.5)	2.6	(0.6)	2.3	(0.8)
D	6	2.8	(0.4)	2.7	(0.8)	2.5	(1.2)

patients (27% of the whole study group), only patients with incomplete lesions.

Regarding bladder and bowel care, the majority of patients needed assistance with voiding and defaecation at admission to the rehabilitation centre. Results of independence at discharge are shown in Table 5. Thirty patients (55% of whole study group) proceeded with intermittent catheterization, 35 (64%) with suprapubic tapping. Most patients in subgroups B, C and D achieved independence in those bladder voiding techniques. Scores of independence in defaecation were low in subgroup A and B. Toilet transfer caused more need for assistance than transfer from bed to chair. Scores for subgroup B were noticeably lower.

Incontinence

Reports about continence at discharge showed that four females (50% of females) were incontinent for urine. One had an indwelling catheter and two were to get a sacral root stimulator soon after discharge. One continent female already had electronic bladder control. Of 47 males 29 (61%) had unpredictable spills of urine and 27 were effectively helped with condom collecting bags. Six patients (11%) were incontinent for faeces, including two females who were also incontinent for urine.

Discussion

The aim of this study was to describe the outcome of a group of patients with SCI. Although we realized that the number of patients was small, we considered it to be a representative group of patients with a traumatic spinal cord lesion in The Netherlands. We found some interesting trends which should have influence on the contents of the rehabilitation programme.

In order to determine the rehabilitation outcome, the functional outcome cannot be studied independently of neurological recovery. In this study we found little change in the extent of lesion during the rehabilitation period. The studies of Waters *et al.* revealed that of complete lesions assessed one month after injury, 90% of

Clinical messages

- Nearly all patients with complete spinal cord lesions at admission to the rehabilitation centre kept complete lesions.
- Significant progress was made in self-care, ambulation, bladder and bowel care.
- Against expectations, patients with complete paraplegia did not achieve maximal independence in self-care.
- Poor results were found in functional bladder and bowel care.

Table 4 Independence rates of four subgroups regarding ambulation at discharge (maximum 3.0)

		Transfer		Wheelchair		Walking	
	N	Mean	(SD)	Mean	(SD)	Mean	(SD)
A	10	1.1	(0.9)	2.7	(0.9)	0	(0)
B	22	2.7	(0.9)	3.0	(0.2)	0.1	(0.4)
C	17	2.8	(0.8)	3.0	(0.0)	2.5	(1.0)
D	6	2.5	(1.2)	3.0	(0.0)	1.8	(1.5)

Table 5 Independence rate of four subgroups regarding bladder and bowel care at discharge (maximum 3.0)

		Bladder void		Defaecation		Toilet transfer	
	N	Mean	(SD)	Mean	(SD)	Mean	(SD)
A	10	1.2	(1.5)	0.3	(0.9)	0.7	(0.9)
B	22	2.9	(0.6)	1.4	(1.5)	1.2	(1.5)
C	17	2.6	(1.0)	2.5	(1.8)	2.8	(0.7)
D	6	2.5	(1.2)	2.5	(1.2)	2.0	(1.5)

those causing tetraplegia and 96% of those causing paraplegia remained complete.[6,7] A one-month postinjury baseline was used, when an accurate examination can be performed as the patient is usually cooperative and acute complications have been resolved.[6–7] In this study the first neurological assessment after admission in the rehabilitation centre took place at, on average, 29 days after the SCI.

Functional recovery was expressed in terms of progress in independence in activities of daily living. Yarkony *et al.* reported that functional improvement after SCI is expected to occur most rapidly during inpatient rehabilitation due to spontaneous neurological recovery, intensity of training and a multidisciplinary approach to problems.[4,22] We found that the study group became significantly more independent in self-care, ambulation, as well as bladder and bowel care. To what extent the rehabilitation programme was responsible for the changes cannot be demonstrated with this study design. However, we also found that patients with permanent complete lesions (subgroups A and B) showed substantial functional improvement.

The functional outcome of tetraplegia has received considerable attention in the literature. The functional motor recovery of the upper extremities of tetraplegics determines final independence in activities of daily living.[14] Regarding the results of patients with complete tetraplegia of subgroup A, we found a high independence score for wheelchair propulsion at discharge. Some of this group became able to eat and dress upper body independently. Training these skills should be an important item on the rehabilitation programme. Nearly all patients in subgroup A remained dependent on assistance in dressing lower body, ambulation and bladder and bowel care. Progress in these skills was not significant and training does not seem very successful.

Most authors agree that patients with levels lower than C7 should be able to accomplish most daily living skills independently, except walking.[5,14] The functional performance of those patients also depends on other factors, like comorbidity, age, spasticity, motivation and coping.[9–11] Patients in subgroup B (with complete lesions below T1) did not achieve maximal independence in dressing lower body, making transfers and bladder and bowel care. Results of defaecation and toilet transfer were poor: even some patients with lesions at lumbar levels did not achieve full independence. Although the results of rehabilitation were encouraging, the functional outcome of this group was not as good as expected based on the theoretical models. This is an important finding if we want to be realistic about the prognosis of patients with complete paraplegia.

Patients with incomplete lesions of subgroup C and D showed reasonably high scores overall. However, it was noted that patients with incomplete paraplegia showed more disabilities in self-care and bladder and bowel care than indicated by their theoretical potential. Impaired hand function might have played a role in some patients with incomplete tetraplegia.

Ambulation has been extensively studied in patients with spinal cord injuries.[15–19] Nene *et al.* presents a review of reports concerning locomotion.[18] There is considerable difference in opinion regarding a patient's ability to walk and the use of orthoses. In this study, patients with complete paraplegia were not able to walk independently over 50 metres. Although the level of lesion does not seem to be very important, by most authors it is generally accepted that patients with complete lesions above T10 are unsuitable for functional locomotion. A diversity of results in those studies is based on major differences in definition and study population. This makes it difficult to compare our results with other studies.

Studies do not often focus on independence in bladder and bowel care. As many patients with SCI do not become continent, it is important that they achieve optimal independence in care in order to prevent incontinence as much as possible. We found poor results, which means that most patients remain dependent on help. In order to reduce the psychosocial consequences, bladder and bowel care should form an important part of the rehabilitation programme. Advances in urological pharmacology and sacral root stimulators may lead to better results in future studies.[23–25]

References

1 World Health Organization. *International Classification of Impairments, Disabilities, and Handicaps*. Geneva: WHO, 1980.
2 Ditunno Jr JF, Young W, Donovan WH, Creasey G. The international standards booklet for neurological and functional classification of spinal cord injury. *Paraplegia* 1994; **32**: 70–80.
3 Schönherr MC, Groothoff JW, Mulder GA, Eisma WH. Rehabilitation of patients with spinal cord lesions in the Netherlands: an epidemiological study. *Spinal Cord* 1996; **34**: 679–83.
4 Yarkony GM, Roth EJ, Heinemann AW, Wu Y, Katz RT, Lovell L. Benefits of rehabilitation for traumatic spinal cord injury. *Arch Neurol* 1987; **44**: 93–96.
5 Woolsey RM. Rehabilitation outcome following spinal cord injury. *Arch Neurol* 1985; **42**: 116–19.
6 Waters RL, Adkins RH, Yakura JS, Sie I. Motor and sensory recovery following complete tetraplegia. *Arch Phys Med Rehabil* 1993; **74**: 242–47.
7 Waters RL, Yakura YS, Adkins RH, Sie I. Recovery following complete paraplegia. *Arch Phys Med Rehabil* 1992; **73**: 784–89.
8 Waters RL, Adkins RH, Yakura JS, Sie I. Motor and sensory recovery following incomplete paraplegia. *Arch Phys Med Rehabil* 1994; **75**: 67–72.
9 Yarkony GM, Roth EJ, Heinemann AW, Lovell L. Spinal cord injury rehabilitation outcome: the impact of age. *J Clin Epidemiol* 1988; **41**: 173–77.
10 DeVivo MJ, Kartus PL, Rutt RD, Stover SL, Fine PR. The influence of age at time of spinal cord injury on rehabilitation outcome. *Arch Neurol* 1990; **47**: 687–91.
11 Lazar RB, Yarkony GM, Ortolano D *et al*. Prediction of functional outcome by motor capability after spinal cord injury. *Arch Phys Med Rehabil* 1989; **70**: 819–22.
12 Yarkony GM, Roth EJ, Heinemann AW, Lovell L. Rehabilitation outcomes in C6 tetraplegia. *Paraplegia* 1988; **26**: 177–85.
13 Rogers JC, Figone JJ. Traumatic quadriplegia: follow-up study of self-care skills. *Arch Phys Med Rehabil* 1980; **61**: 316–21.
14 Welch RD, Lobley SJ, O'Sullivan SB, Freed MM. Functional independence in quadriplegia: critical levels. *Arch Phys Med Rehabil* 1986; **67**: 235–40.
15 Mizukami M, Kawai N, Iwasaki Y *et al*. Relationship between functional levels and movement in tetraplegic patients. A retrospective study. *Paraplegia* 1995; **33**: 189–94.
16 Hussey RW, Stauffer ES. Spinal cord injury: requirements for ambulation. *Arch Phys Med Rehabil* 1973; **54**: 544–47.
17 Waters RL, Yakura JS, Adkins R, Barnes G. Determinants of gait performance following spinal cord injury. *Arch Phys Med Rehabil* 1989; **70**: 811–18.
18 Nene AV, Hermens HJ, Zilvold G. Paraplegic locomotion: a review. *Spinal Cord* 1996; **34**: 507–23.
19 Crozier KS, Ling Ling Cheng, Graziani V, Zorn G, Herbison G, Ditunno JF. Spinal cord injury: prognosis for ambulation based on quadriceps recovery. *Paraplegia* 1992; **30**: 762–67.
20 ASIA/IMSOP. *Standards for neurological and functional classification of spinal cord injury*, revised 1992. Chicago: American Spinal Injury Association, 1992.
21 Waters RL, Adkins RH, Yakura JS. Definition of complete spinal cord injury. *Paraplegia* 1991; **29**: 573–81.
22 Yarkony GM, Roth EJ, Heinemann AW, Lovell L, Wu Y. Functional skills after spinal cord injury rehabilitation: three-year longitudinal follow-up. *Arch Phys Med Rehabil* 1988; **69**: 111–14.
23 Wyndaele JJ. Development and evaluation of the management of the neuropathic bladder. *Paraplegia* 1995; **33**: 305-307.
24 Timoney AG, Shaw PJR. Urological outcome in female patients with spinal cord injury: the effectiveness of intermittent catheterisation. *Paraplegia* 1990; **28**: 556–63.
25 Brindley GS. The first 500 patients with sacral anterior root implants. *Paraplegia* 1994; **32**: 795–805.